



CLEAN VERSION OF THE AMENDED CLAIMS

RECEIVED
FEB 24 2003

TECHNOLOGY CENTER 2800

C3

1. (three times amended) A method for contactless measurement of a wall thickness of a transparent object by employing of light sources, lenses, deflection mirrors or deflection prisms, semi permeable mirrors as well as line sensors and a controller, characterized in that light from a first illuminating surface (11) is initially collimated and in the following focused onto a surface of the transparent object (1) with an angle of incidence relative to a normal of the surface, wherein two reflexes of light occurring at a front side (1.1) and at a rear side (1.2), are imaged furthermore onto a second opto-electronic image resolving sensor (26) and wherein light from a second illuminating surface (21) is also simultaneously collimated initially and in the following focused in the direction toward the surface of the transparent object (1), wherein the direction toward the surface of the transparent object (1) corresponds to an exit direction of the light from the first illuminating surface (11), and wherein reflexes of light are imaged onto a second opto-electronic image resolving sensor (16) and wherein the average value of distances between respective two reflexes on each of the two opto-electronic image resolving sensors is evaluated as a measure of the wall thickness in a following disposed controller (3).

2. (three times amended) A device for contactless measurement of wall thickness of a transparent object (1) employing light sources, lenses, semi permeable mirrors or semi permeable prisms as well as image resolving sensors and a controller, characterized in that a first lens (12) is disposed following to a first illuminating surface (11), wherein a

C3
C20

first semi permeable mirror (13) is disposed behind the first lens (12) in such a way that light is reflected into a first objective (14) and is further focused onto the transparent object (1) and wherein a second objective (24) is disposed such that the second objective (24) together with a fourth lens (25) images beams reflected at the transparent object (1) onto a second sensor (26) through a second semi permeable mirror (23) and wherein a second lens (22) is simultaneously coordinated to a second illuminating surface (21), wherein a second semi permeable mirror (23) is disposed following to the second lens (22) in such a way that light from the second illuminating surface (21) is focused also onto the transparent object (1), wherein the direction of incidence of light corresponds to an exit direction of light from the first illuminating face and wherein reflexes are imaged onto a first sensor (16) through the first objective (14), wherein a controller (3) is connected to the two sensors (16 and 26).

C4

3. (twice amended) The device according to claim 2, characterized in that the first illuminating surface (11) and the second illuminating surface (21) are light exit openings of light guides.

C5

4. (amended) The device according to claim 3, characterized in that the respective light exit opening of the light guides is formed of line shape.

C6

5. (twice amended) The device according to claim 2 characterized in that the first illuminating surface (11) and the second illuminating surface (21) are furnished with lasers and with beam expansion optics.

6. (twice amended) The device according to claim 2, characterized in that the first illuminating surface (11) and the second illuminating surface (21) are furnished by light sources with predisposed slot diaphragms.

7. (amended) A device for contactless measurement of wall thickness of container glass of transparent object (1) with a front side (1.1) and an inner side (1.2) comprising

- a first illuminating surface (11) and a second illuminating surface (21) for generating diverging light beams;

- a first lens (12) and a second lens (22) for generating parallel light beams from the diverging light beams generated by the illuminating surfaces (11) and (21) respectively;

- a first semi-permeable mirror (13) for selective light beam reflection or transmission;

- a second semi-permeable mirror (23) for selective light beam reflection or transmission;

- a first objective (14) and a second objective (24) for focusing and generating parallel light beams;

- a first sensor (16) and a second sensor (26);

- a third lens (15) and a fourth lens (25) for focusing light beams onto the first sensor (16) and the second sensor (26) respectively;

- a controller (3) for averaging values determined by the first sensor (16) and the second sensor (26).

8. (amended) A method for performing contactless measurement of a wall thickness of transparent container glass comprising

- generating diverging light beams with a first illuminating surface (11) and with a second illuminating surface (21);

- generating parallel light beams from the diverging light beams with a first lens (12) and with a second lens (22) and directing the generated parallel light beams by

reflection from a first semipermeable mirror (13) and from a second semipermeable mirror (23);

focusing the directed parallel light beams onto a transparent object (1) having a front side (1.1) and a rear side (1.2)

reflecting focused parallel light beams from the front side (1.1) and the rear side (1.2);

generating parallel light beams from the diverging light beams reflected by the front side (1.1) and by the rear side (1.2) by a first objective (14) and by a second objective (24);

focusing the parallel light beams with a fourth lens (25) and with a third lens (15) and obtaining light values of focused parallel light beams with a second sensor (26) and with a first sensor (25);

analyzing obtained light values; and

determining a wall thickness of the transparent object (1) with a controller (3).

11. (amended) A device for contactless measurement of a wall thickness of a container glass being a transparent object (1) with a front side (1.1) and a rear side (1.2) comprising

a first illuminating surface (11) for generating first diverging light beams;

a first lens (12) disposed in the area of the first diverging light beams and for generating first parallel light beams from the diverging light beams generated by the first illuminating surface (11);

a first semi-permeable mirror (13) disposed in a path of the first parallel light beams for reflecting the first parallel light beams;

a first objective (14) disposed in a path of reflected first parallel light beams for focusing the reflected first parallel light beams in the area of the front side (1.1) and rear side (1.2) of the transparent object (1);

a second objective (24) disposed in a path of first light beams reflected in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) for collimating the first light beams into third parallel light beams;

a second semi-permeable mirror (23) disposed in a path of the third parallel light beams for passing the third parallel light beams;

a second sensor (26);

a fourth lens (25) disposed in the path of the third parallel light beams for focusing the third parallel light beams onto the second sensor (26);

a second illuminating surface (21) for generating second diverging light beams;

a second lens (22) disposed in the area of the second diverging light beams and for generating second parallel light beams from the second diverging light beams generated by the second illuminating surface (21);

wherein the second semi-permeable mirror (23) is disposed in a path of the second parallel light beams for reflecting the second parallel light beams;

wherein the second objective (24) is disposed in the path of the reflected second parallel light beams for focusing the reflected second parallel light beams in the area of the front side (1.1) and rear side (1.2) of the transparent object (1);

wherein the first objective (14) is disposed in a path of second light beams reflected in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) for collimating the second light beams into fourth parallel light beams;

wherein the first semi-permeable mirror (13) is disposed in a path of the fourth parallel light beams for passing the fourth parallel light beams;

a first sensor (16);

a third lens (15) disposed in the path of the fourth parallel light beams for focusing the fourth parallel light beams onto the first sensor (16);

a controller (3) connected to the first line sensor (16) and connected to the second line sensor (26) for averaging values determined by the first line sensor (16) and determined by the second line sensor (26).

19. (amended) A method of contactless measurement of a wall thickness of container glass being a transparent object (1) with a front side (1.1) and a rear side (1.2) comprising the steps of:

generating first diverging light beams on a first illuminating surface (11);

generating first parallel light beams from the diverging light beams generated by the first illuminating surface (11) with a first lens (12) disposed in the area of the first diverging light beams;

reflecting the first parallel light beams with a first semi-permeable mirror (13) disposed in a path of the first parallel light beams;

focusing reflected first parallel light beams in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) with a first objective (14) disposed in a path of the reflected first parallel light beams;

collimating first light beams into third parallel light beams with a second objective (24) disposed in a path of first light beams reflected in the area of the front side (1.1) and rear side (1.2) of the transparent object (1);

passing the third parallel light beams through a second semi-permeable mirror (23) disposed in a path of the third parallel light beams;

focusing the third parallel light beams onto a second sensor (26) with a fourth lens (25) disposed in the path of the third parallel light beams;

generating second diverging light beams with a second illuminating surface (21);

generating second parallel light beams from the second diverging light beams generated by the second illuminating surface (21) with a second lens (22) disposed in the area of the second diverging light beams;

reflecting the second parallel light beams with the second semi-permeable mirror (23) disposed in a path of the second parallel light beams;

focusing the reflected second parallel light beams in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) with the second objective (24) disposed in the path of the reflected second parallel light beams;

collimating second light beams reflected in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) into fourth parallel light beams with the first objective (14) disposed in a path of the second light beams ;

passing the fourth parallel light beams through the first semi-permeable mirror (13) disposed in a path of the fourth parallel light beams;

focusing the fourth parallel light beams onto a first sensor (16) with a third lens (15) disposed in the path of the fourth parallel light beams;

cg
cont averaging values determined by the first line sensor (16) and determined by the second line sensor (26) in a controller (3) connected to the first line sensor (16) and connected to the second line sensor (26).

C10 21. (new) The method according to claim 19 further comprising
impinging onto the object (1) from different angles of incidence with the reflected first parallel light beams focused in the area of the front side (1.1) and rear side (1.2) of the transparent object (1); and

impinging onto the object (1) from different angles of incidence with the reflected second parallel light beams focused in the area of the front side (1.1) and rear side (1.2) of the transparent object (1).

22. (new) The method according to claim 19 further comprising
entering parts of the first light beams reflected in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) into the second objective (24) despite a grained, uneven surface of the object and even though other parts of the first light beams are not available based on surface defects of the object (1); and
entering parts of the second light beams reflected in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) into the first objective (24) despite a grained, uneven surface of the object and even though other parts of the second light beams are not available based on surface defects of the object (1).

23. (new) A method according to claim 8 wherein the semi-permeable mirror (13) performs reflecting and directing light beams generated by the first illuminating surface (11) and transmission of light beams generated by the second illuminating surface (21) and further reflected from the front side (1.1) and the rear side (1.2) of the transparent object (1); wherein the semi-permeable mirror (23) performs reflecting and directing light beams generated by the second illuminating surface (21) and transmission of light beams generated by the first illuminating surface (11) and further reflected from the front side (1.1) and the inner side (1.2) of the transparent object (1).

24 (new) A method for contactless measurement of a wall thickness of a transparent object by employing of light sources, lenses, deflection mirrors or deflection prisms, semi permeable mirrors as well as line sensors and a controller, characterized in that light from a first illuminating surface (11) is initially collimated through a first lens (12) and in the following through a first semi-permeable mirror (13) and further through a first objective (14) focused onto a surface of the transparent object (1) with an angle incidence relative to a normal of the surface, wherein two reflexes of light, which reflexes occur at a front side (1.1) and at a rear side (1.2), are imaged through a second objective (24), through a second semi-permeable mirror (23) and further through a forth lens (25) furthermore onto a second opto-electronic image resolving sensor (26) and wherein light from a second illuminating surface (21) is simultaneously also initially collimated through a second lens (22) and in the following through a second semi-permeable mirror (23) and further through the second objective (24) focused in the direction toward the surface of the transparent object (1), wherein the direction toward the surface of the transparent object (1) corresponds to the exit direction of the light from the first illuminating surface (11), and wherein furthermore reflexes of light are imaged through the first objective (14), through the first semi-permeable mirror (13) and further through a third lens (15) onto a first opto-electronic image resolving sensor (16) and wherein the average value of the distances of the respective two reflexes on the two opto-electronic image resolving sensors is evaluated as a measure of the wall thickness in a following disposed controller (3).

25. (new) A method of contactless measurement of a wall thickness of container glass being an object (1) with a front side (1.1) and a rear side (1.2) comprising the steps of:

generating first diverging light beams on a first illuminating surface (11);
collimating the diverging light beams generated by the first illuminating surface (11) for generating first parallel light beams;

passing the first parallel light beams by a first optical beam splitter (13) disposed in a path of the first parallel light beams;

focusing first parallel light beams having passed the first optical beam splitter (13) in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) with a first optical focusing and in reverse collimating system (14) disposed in a path of the first parallel light beams having passed the first optical beam splitter (13);

collimating first light beams reflected from the object (1) into third parallel light beams with a second optical focusing and in reverse collimating system (24) disposed in a path of first light beams reflected in the area of the front side (1.1) and rear side (1.2) of the object (1);

passing the third parallel light beams through a second optical beam splitter (23) disposed in a path of the third parallel light beams;

focusing the third parallel light beams onto a second light incidence position resolving sensor (26);

generating second diverging light beams with a second illuminating surface (21);

collimating the second diverging light beams generated by the second illuminating surface (21) for generating second parallel light beams;

passing the second parallel light beams by the second optical beam splitter (23) disposed in a path of the second parallel light beams;

focusing the second parallel light beams after passing the second optical beam splitter (23) in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) with the second optical focusing and in reverse collimating system (24) disposed in the path of the second parallel light beams;

collimating second light beams reflected in the area of the front side (1.1) and rear side (1.2) of the transparent object (1) into fourth parallel light beams with the first optical focusing and in reverse collimating system (14) disposed in a path of the second light beams;

passing the fourth parallel light beams through the first optical beam splitter (13) disposed in a path of the fourth parallel light beams;

focusing the fourth parallel light beams onto a first light incidence position resolving sensor (16);

averaging values determined by the first light incidence position resolving sensor (16) and determined by the second light incidence position resolving sensor (26) in a controller (3) connected to the first light incidence position resolving sensor (16) and connected to the second sensor (26).

26. (new) The device, according to claim 7, characterized in that diverging light beams are generated by the first illuminating surface (11) and the second illuminating surface (21); wherein diverging light beams generated by the first illuminating surface (11) converted to parallel light beams through the first lens (12), reflected into the direction of the first objective (14) through the first semi-permeable mirror (13), further through the first objective (14) are focused onto the transparent object (1) and wherein diverging light beams generated by the second illuminating surface (21) converted to parallel light beams through the second lens (22), reflected into the direction of the second objective (24) through the second semi-permeable mirror (23), further through the second objective (24) are focused onto the transparent object (1); wherein focused light beams passing from the first objective (14) and reflected from the transparent object (1) and consisting of reflexes from the front side (1.1) and the inner side (1.2) are imaged through the second objective (24), through the second semi-permeable mirror (23) and further through the forth lens (25) onto the second sensor (26) and wherein focused light beams passing from the second objective (24) and reflected from the transparent object (1) and consisting of reflexes from the front side (1.1) and the inner side (1.2) are imaged through the first objective (14), through the first semi-permeable mirror (13) and further through the third lens (15) onto the first sensor (16); wherein the controller (3) connected to the first sensor (16) and the second sensor (26) determines the distance of reflexes on the first sensor (16) and the second sensor (26) and finally determines the wall thickness of the transparent object (1) by averaging of the distances of the reflexes on the two sensors (16, 26).

27. (new) A device for contactless measurement of a wall thickness of an object (1) with a front side (1.1) and a rear side (1.2) comprising

a first illuminating surface (11) for generating first diverging light beams;

a first optical collimator (12) disposed in the area of the first diverging light beams and for generating first parallel light beams from the diverging light beams generated by the first illuminating surface (11);

a first optical beam splitter (13) disposed in a path of the first parallel light beams for passing the first parallel light beams;

a first optical focusing and in reverse collimating system (14) disposed in a path of passed first parallel light beams for focusing the passed first parallel light beams in the area of the front side (1.1) and rear side (1.2) of the transparent object (1);

a second optical focusing and in reverse collimating system (24) disposed in a path of first light beams reflected in the area of the front side (1.1) and rear side (1.2) of the object (1) for collimating the first light beams into third parallel light beams;

a second optical beam splitter (23) disposed in a path of the third parallel light beams for passing the third parallel light beams;

a second light incidence position resolving sensor (26);

a fourth optical focusing system (25) disposed in the path of the third parallel light beams for focusing the third parallel light beams onto the second light incidence position resolving sensor (26);

a second illuminating surface (21) for generating second diverging light beams;

a second optical collimator (22) disposed in the area of the second diverging light beams and for generating second parallel light beams from the second diverging light beams generated by the second illuminating surface (21);

wherein the second optical beam splitter (23) is disposed in a path of the second parallel light beams for passing the second parallel light beams;

wherein the second optical focusing and in reverse collimating system (24) is disposed in the path of the passed second parallel light beams for focusing the passed second parallel light beams in the area of the front side (1.1) and rear side (1.2) of the transparent object (1);

wherein the first optical focusing and in reverse collimating system (14) is disposed in a path of second light beams reflected in the area of the front side (1.1) and

rear side (1.2) of the transparent object (1) for collimating the second light beams into fourth parallel light beams;

wherein the first optical beam splitter (13) is disposed in a path of the fourth parallel light beams for passing the fourth parallel light beams;

a first light incidence position resolving sensor (16);

a third optical focusing system (15) disposed in the path of the fourth parallel light beams for focusing the fourth parallel light beams onto the first light incidence position resolving sensor (16);

a controller (3) connected to the first light incidence position resolving sensor (16) and connected to the second light incidence position resolving sensor (26) for averaging values determined by the first light incidence position resolving sensor (16) and determined by the second light incidence position resolving sensor (26).
